REFERENCE DATA CODING IN SOLID STATE IMAGE SENSORS

Field of the Invention

The present invention relates to solid state image sensors, and more particularly, to encoding data in a solid state image sensor. The invention may be used for encoding any type of reference data, but is particularly useful for recording color processes and mask revision codes.

Background of the Invention

Recording reference data on a variety of types of microchips, including solid state image sensors, during manufacture of the chips is well known. Such data may include product codes and the like, and may be encoded in the chip circuitry using a variety of coding schemes. In the case of an image sensor, such reference data may identify the particular type of the basic sensor chip, for example.

However, the same basic sensor chip may provide the basis for a variety of different image sensors which differ in terms of the color processing applied to the basic sensor chip. The details of the color processing determine the characteristics of the color filter mosaic and microlens array applied to the chip, for example. It is not practical to record such data in the chip circuitry during manufacture of the

basic sensor chip since the details of the subsequent color processing may not be known at the time of manufacture of the basic sensor chip.

Solid state image sensors generally comprise an array of light sensitive elements (pixels) arranged in rows and columns, together with associated circuitry for reading signals from the pixel array. All of the pixels of the array are connected to the associated circuitry and are capable of being read, but a number (typically two to eight) of the rows and columns of pixels around the periphery of the pixel array are not actually used in the image signals output from the sensor. These unused pixels are commonly referred to as border pixels.

Summary of the Invention

The invention, in its various aspects, is defined in the Claims appended hereto.

Brief Description of the Drawings

Embodiments of the invention will now be described, by way of example only, with reference to the accompanying drawings, in which:

FIG. 1 is a schematic block diagram illustrating a generic solid state image sensor or image sensing system according to the prior art; and

FIG. 2 is a diagram illustrating an embodiment of a data coding scheme in accordance with the present invention.

Detailed Description of the Preferred Embodiments

Referring now to the drawings, FIG. 1 shows a generic solid state image sensor/sensing system that includes a sensor array 10, and vertical and horizontal shift registers 12 and 14 used for reading output signals from the sensor array. The sensor array 10 comprises an array of photosensitive pixels arranged in

lines and columns. The image sensor/sensing system further includes control means 16 for controlling the operation of the shift registers 12, 14, and signal processing means 18 for processing image signals from the array 10, which are output via the horizontal shift register 14.

The arrangement of the sensor as described thus far is generic for a variety of conventional image sensors and will not be described in further detail. It will be understood that the control means 16 and signal processing means 18 may be implemented in hardware, firmware or software and may be integrated on-chip with the sensor array 10, or located off-chip, locally or remotely, or combinations thereof.

Generally speaking, the input to the signal processing means 18 will be analog. The signal processing means may include analog-digital conversion means, digital signal processing means for a performing any of a variety of signal processing functions as are well known in the art, and storage means for storing one or more images and/or portions of images for a variety of purposes.

As is well known in the art, the pixels of a number of rows and columns around the periphery of the pixel array 10, typically two to eight rows/columns, are designated as border pixels, indicated by reference numeral 20 in FIG. 1. The border pixels are fully functional pixels but, in normal use of the sensor, they are either not read or their output signals are ignored. That is, their outputs do not form part of the image signal produced by the sensor.

It is known to encode data, such as product codes, in the electronic circuitry of the basic sensor chip during manufacture thereof. As is also well known in the art, a color image sensor is produced by applying color processing to a basic sensor chip of the type described above. Typically, color processing

involves the application of a color filter mosaic to the pixel array 10. Color processing may also include the application of a microlens array on top of the color filter mosaic to improve the light gathering capacity of the pixels.

The color filter mosaic may have any of a variety of well known configurations, using a variety of different color combinations. These color combinations typically include three primary colors such as red, green and blue or complementary colors such as cyan, magenta and yellow to produce a full color image output from the sensor. One example of a color filter pattern is the well known Bayer pattern, in which the pixels of the basic array 10 are grouped in blocks of four, with the pixels at two diagonally opposite corners of each block being colored green and the remaining two pixels being colored red and blue respectively.

It is common for a number of different color processes having different parameters to be applied to basic sensor chips of the same type. It is also common for different versions (revisions) of a color process mask to be used. It is useful for the sensor to have information recorded thereon regarding the color process applied and/or mask revision used on that particular sensor. It is not practical to encode such data in the circuitry of the basic chip during manufacture thereof.

In accordance with the present invention, data is encoded in the color processing applied to at least some of the border pixels of the basic sensor chip. The recorded data may be read during manufacture of the sensor, subsequent assembly of an imaging system using the sensor, or subsequent use of the sensor.

FIG. 2 illustrates a preferred example of a data encoding scheme in accordance with the invention. At 30 there are shown two adjacent blocks of four

pixels of a standard Bayer pattern color filter mosaic, with each block including two green pixels G, a red pixel R and a blue pixel B as described above. Binary data can be encoded in the color filter mosaic applied to the border pixels as logic 0s and logic 1s as shown at 32A and 32B, 34A and 34B, and 36A and 36B respectively.

In this example, a logic 0 is encoded at 32A by omitting the red color filter element from the right hand block, and a logic 1 is encoded at 32B by omitting the red color filter element from the left hand block. When the sensor is illuminated by incident light and signals are read out from the relevant pixels, it is possible to discriminate between a signal from a pixel having a color filter element and a pixel with no color filter element. The manner in which such signals may be discriminated is well known in the art (e.g., from error detection algorithms used in conventional image sensors) and will not be described in detail herein.

It will be understood that binary data may be encoded in the color processing by varying the color processing applied to individual border pixels in any way which may be discriminated when signals are read out from the pixels. This may be done by omission of any one color element or combinations of color elements. Alternatively, instead of omitting a color element, multiple colors may be applied to the same pixel, making the filter element substantially or completely opaque.

References 34A/B shows a logic 0 and logic 1 encoded by omission of green filter elements, while references 36A/B shows a logic 0 and logic 1 encoded by omission of blue filter elements. Red, green and blue coding of the type illustrated may be combined in the same color filter mosaic.

Alternatively or in addition to encoding data in the color filter mosaic pattern, data may be encoded

in the microlens array applied to the sensor. This is illustrated at 38A and 38B, where a logic 0 is encoded by omitting microlenses 40 from the left hand block of pixels, and a logic 1 is encoded by omitting microlenses 40 from the right hand block of pixels.

Any type of data may be encoded using the method of the present invention. However, the invention is particularly intended for encoding color process information and/or mask revision information, preferably in combination with a product code. The relevant information requires a relatively small number of bits. An example is illustrated at 42 in FIG. 2, where the data comprises a start code of 4 bits (one nibble), a product code comprising three nibbles (3 x 4 bits), a color process code of four bits, a mask revision code of four bits and an end code of 4 bits. This data is easily accommodated in the number of border pixels available in a typical image sensor.

It will be understood that the coding scheme may vary from the illustrated examples, and may be adapted for use with any type of color filter mosaic or microlens array. The data encoded in the color processing may be read at any time during the life of the sensor by illuminating the sensor and interpreting the output from the border pixels.

Algorithms for reading the data may be incorporated in the sensor or sensor system or may be provided separately from the sensor/system. Preferably, the sensor or system circuitry is provided with storage means for electronically storing the data read from the border pixels so that the data is available for use by signal processing algorithms during subsequent use of the image sensor/system. Improvements and modifications may be incorporated without departing from the scope of the invention.